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Hypermetamorphosis of *Rhacopus attenuatus* (MAEKLIN) (*Coleoptera, Eucnemidae*)

[With 37 Text-figures]

Abstract. A description is given of the developmental stages of *Rhacopus attenuatus* (MAEKLIN) from Poland. Five instars are recognized, and the first instar is of the triungulin type. This is the first time triungulin has been found in the coleopterous family *Eucnemidae*. The structure of the male and female terminalia, and the bionomics are also provided.

Rhacopus attenuatus, previously in *Hypocaelus*, was described in 1845, however little information has been published on its immature stages and bionomics. The European species *Rh. sahlbergi* (MANNERHEIM) is the only representative of the genus with a known mature larva (PALM 1958, 1960; LEILER 1976). The larva, pupa and habitat were briefly mentioned by a mistake under the name *Xylophilus cruentatus* (BURAKOWSKI and ŚLIWIŃSKI 1981; BURAKOWSKI, MROCZKOWSKI and STEFAŃSKA 1985), but they were not formally described.

This paper describes for the first time the earlier instar larvae, including first one (triungulin), pupa, male and female abdominal terminalia, and the bionomics of *Rh. attenuatus* (MAEKLIN).

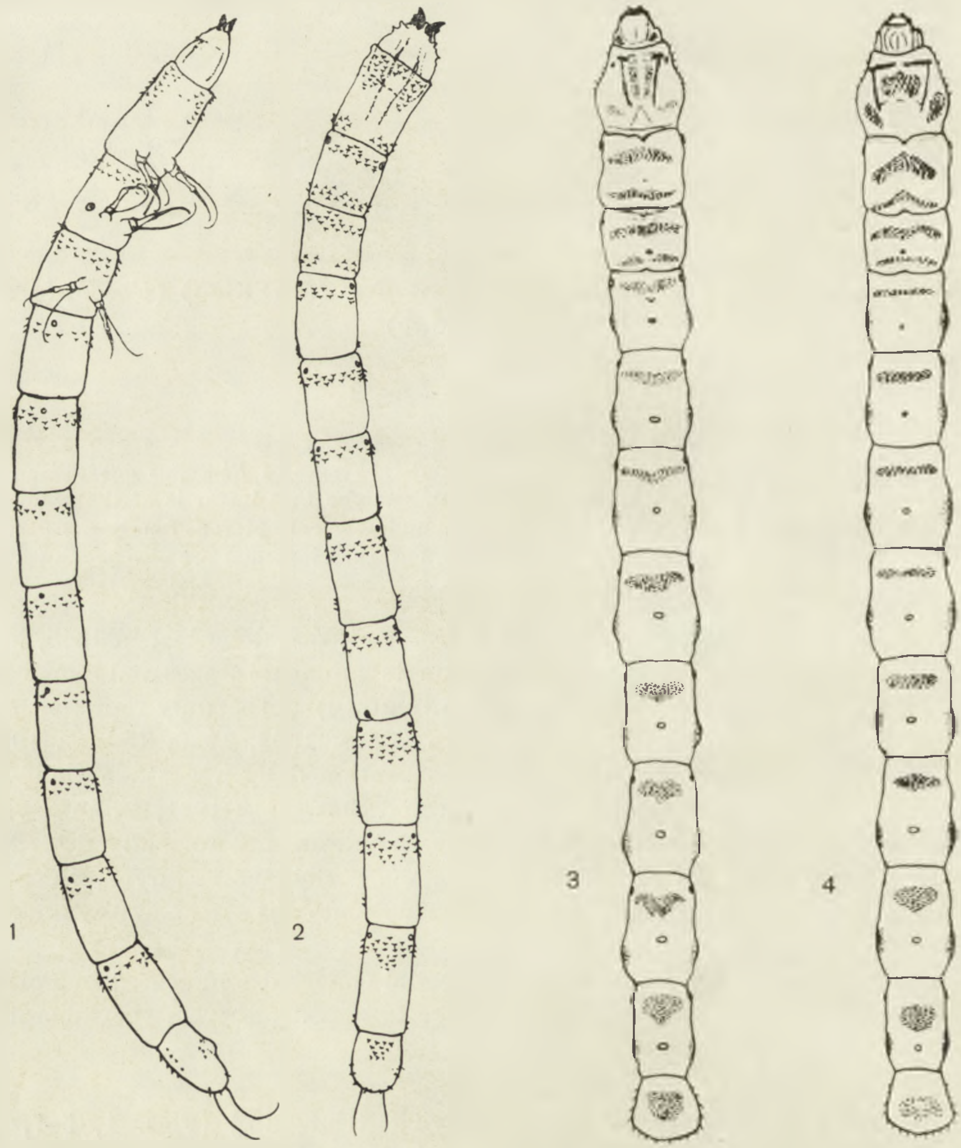
The descriptions are based on the material collected and reared in Poland. Biological and ecological observations were obtained either in the laboratory or in the field.

First-instar larva (Non-feeding free-living triungulin) (Figs. 1, 5–7, 15)

Form elongate, subcylindrical, slightly flattened, subparallel, with the front part of head sharp and almost chisel-like, and posterior segment widely

rounded apically. Length of distended larva 1–1.3 mm; head width 0.05 mm. Epiderm feebly sclerotized, whitish except the anterior part of head, which is yellowish.

Head capsule distinctly longer than wide, strongly depressed, deeply retracted in prothorax, much narrower than prothorax. Mandibles relatively slender and prominent at apex of head; each with three outwardly directed rather



Figs. 1–4. *Rh. attenuatus*, larva. 1 – first-instar (triungulinus), 2 – second-instar, 3 – mature larva, dorsal, 4 – mature larva, ventral.

acute teeth (fig. 15), apical tooth much stronger than remaining two and bears minute tubercle on outer margin; each mandible is supported on its outer side by sclerotized socket. Antenna retractile, situated laterally to support mandible socets, consists of cylindrical basal segment bearing inner conical sensory appendage apically, and narrower outer segment bearing a few minute papillae apically. Lateral to antenna there is distinct but weakly sclerotized, outwardly curved prominence bearing few teeth at posterior margin. Mouth-parts ventral, extremely minute, visible as slight protuberances.

Thorax about 0.25 × as long as total body length. Prothorax (fig. 5) twice as long as wide, with longitudinal patches of scales. These patches are made up of minute scales directed backwards, in groups of 3–5 with median scale longer and smaller one (or 2) on each side. Meso- and metathorax with narrow, transverse patch of scales near anterior margin.

Legs (Figs. 5, 7) well developed, rather widely separated, 4-segmented, similar to each other. Coxa sessile, subovate; trochanter short, with long filament reaching beyond the apex of leg; femur long, rough at extremities; tibio-tarsus slender fused with curved and acute claw.

Abdominal segments I–VIII subequal, similar to each other; each segment anteriorly with narrow, transverse patch of scales. Segment IX (fig. 6) subconical, shorter than preceding one, with few scales and two long filaments apically; sternite IX with semicircular row of blunt triangular spines near middle.

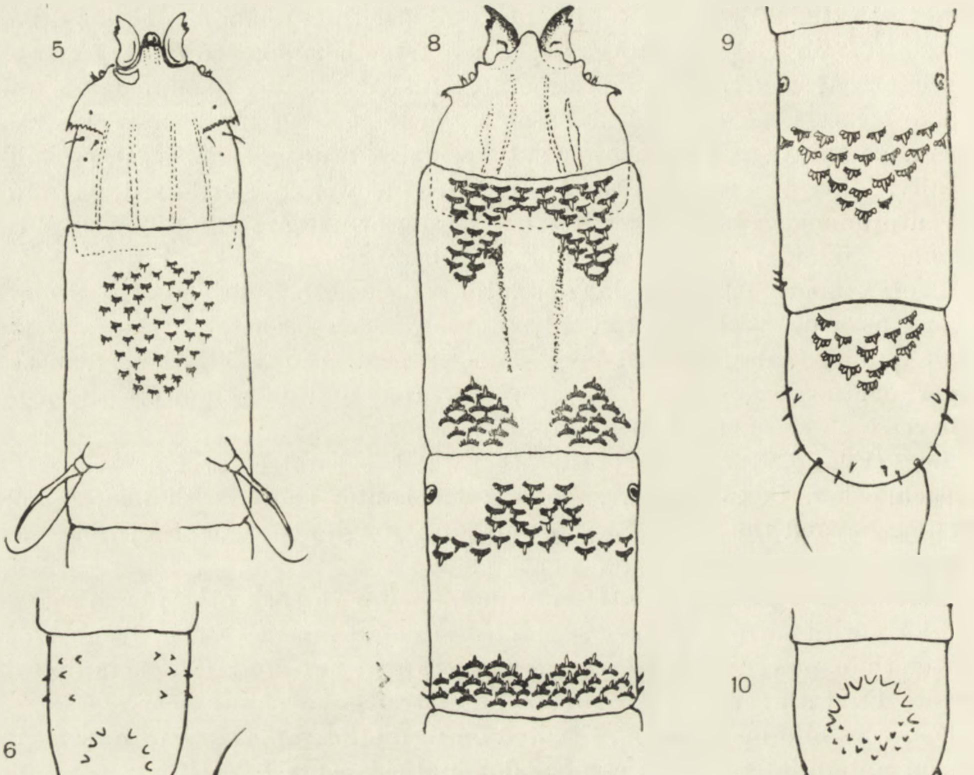
Spiracles biforous, 9 pairs, situated on medio-lateral surface of mesothorax, and on antero-lateral surfaces of abdominal segments I–VIII.

Remarks

The first-instar larva is an active, long-legged triungulin-type, differing much from the second-instar and subsequent ones, thus hypermetamorphosis occurs in *Rh. attenuatus*. The triungulin of this species is very different from other known triungulins of the families ***Meloidae***, ***Rhipiphoridea***, ***Micromalthidae***, ***Bothrideridae*** or ***Passandridae***. Triungulins of ***Meloidae*** have the tarsus consisting of 3 claws apically, while the ***Rhipiphoridae*** have a single claw at the base of a pulvillus; *Micromalthus* has 3-segmented legs with a distinct tarsus bearing 2 claws. Both cucujiform *Passandridae* and *Bothrideridae* triungulins are much different having strongly spinose dorsal surfaces, single ocellus on each side of head, and annular spiracles. The triungulin of *Rh. attenuatus* has four segmented legs with falciform claw, and a long filament on trochanter. It seems to swim in drops of water.

Second-instar larva (Figs. 2, 8–10, 16)

This instar is generally similar to the first one in body-shape but legless, and in relation to body-length the abdominal segment IX, head and abdominal filaments are shorter than in the triungulin.



Figs. 5–14. *Rh. attenuatus*, larva. 5 – head and prothorax, ventral, 6 – last abdominal segment, ventral, 7 – leg, 8 – head, pro- and mesothorax, dorsal, 9 – abdominal segments VIII–IX, dorsal, 10 – abdominal segment IX, ventral, 11 – spiracle, 12 – antenna, 13 – – labium, 14 – arrangement of scales on velvety areas. 5–7 – first-instar, 8–10 – second-instar, 11–14 – mature larva.

Length of distended larva 1.8–2.0 mm. Head width 0.1 mm.

Head (Fig. 8) transverse, more heavily sclerotized with paired corneous lines extending back to posterior margin. Mandible (fig. 16) with 3 outwardly directed teeth, the first much stronger than the others, the third is larger than the second tooth.

Dorsal and ventral side of prothorax with two longitudinal yellowish scleromes. Thoracic segments with patches of scarce scales near anterior and posterior margin; scales near anterior margin directed backwards, those near posterior margin directed forwards.

Spiracles biforous, mesothoracic somewhat larger than abdominal, situated near anterio-lateral margins of mesothorax and on abdominal segments I–VIII.

Abdominal segments I–V with narrow transverse patch of sparse scales near anterior margin; VI–IX segments with larger patches of scales, all directed backwards; few scales directed forwards on postero-lateral part of segments I–VIII. Segment IX (Figs. 2, 8) subconical, about twice as short as preceding one, with two moderately long filaments apically, few and short spines on posterior part of segment; ventral side with smaller and larger spines situated circularly.

Remarks

The legless second-instar larvae are reminiscent of some dipterous larvae, with which they might be confused, but the outwardly directed mandibular teeth of eucnemid larvae easily distinguish them from those of the *Stratiomyiidae*, *Asilidae* and other *Diptera*.

Third-instar larva (Fig. 17)

Body length 4.0–5.0 mm; head length 0.3 mm, head width at base 0.35 mm.

Its general form differs from that of second-instar and similar to the mature larva, but L-shaped sclerotisations on prothorax and the velvety areas on thorax and abdomen are much less conspicuous than in later instars. Mandible is much less protruded forwards than in the second-instar, obliquely transverse with the second and third tooth fused to form a wide, bifid one (Fig. 17). Last abdominal segment without filaments.

Fourth-instar larva

Body length 6.0–7.0 mm; head length 0.4 mm, head width at base 0.5 mm.

Larvae of the fourth-instar greatly resemble those of later instars, and there are no much differences except measurements as noted above.

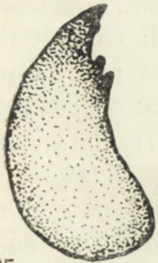
Mature larva (Figs. 3–4, 11–14, 18–23)

Body length 14.0–16.0 mm, if fully expanded about 18 mm; maximum body width 1.40 mm; head length 0.7 mm, head width 0.9 mm.

Body elongate, subcylindrical, slightly depressed, constricted between elongate segments.. Without ocelli, legs and sutures on thoracic and abdominal segments, which are separated by simple, weak intersegmental constrictions. Vestiture consists of sparse and minute setae. Body white-yellowish, feebly sclerotized except head, longitudinal sclerones on prothorax, spiracles and apex of abdominal segment IX, which are dark-brown or red-brownish and heavily sclerotized.

Head (Figs. 19, 20) flattened, subtriangular, moderately transverse, with arcuate lateral and posterior margins. Occipital foramen large. Head is partly retracted within prothorax, and may move laterad. Head surface dark-brown medially, reddish-brown laterally, smooth and shiny. Suboval cephalic disk with longitudinal, low carina; lateral, longitudinal, arcuate furrows and ridges on dorsal and ventral surfaces. Mouth frame heavily sclerotized to support mandibles, dorsally broadly triangular, ventrally with distinct arcuate sulcus. Along cephalic margin on each side there is small, blunt, dark protuberance directed anteriorly, and two larger, brownish and weakly sclerotized serrations curving outwards; caudad this area is serrate on ventro-posterior edge, and behind second serration there is deeper incision and blunt protuberance directed forwards. Labrum semicircular; large frontoclypeal region fused with epicranium without sutures. Mandible (Fig. 18) well sclerotized and pigmented, flattened, short, semicircular, wider than long and obliquely oriented with the cutting edge under angle 40–45°; medial surface convex and continuous with large, first, acute tooth on apical face; anterolateral surface evenly convex with large and wide tooth. Postero-dorsal and postero-ventral edges with large acetabulum which moves in horizontal plane, so that mandible cuts and pushes wood fibres laterally. Thus large tendon and muscle (adductor) are attached laterally, and small tendon and muscle (abductor) are attached medially. Labium (Fig. 13) extremely minute, weakly sclerotized, retractile, only extreme tips are visible, consists of three equal segments with two sensillae apically; labial palps 3-segmented, apical palpomere with 2 sensillae apically. Digestive tract simple, forms membraneous, thin tube. Oral opening in form of small slit on anterior, sharp edge of head. Antenna (Fig. 12) very short, 2-segmented, retractile, inserted in nonsclerotized area between dark-brown protuberance and first lateral serration; basal antennomere short and cylindrical, mostly concealed, distally bearing single medium-sized conical sensory appendage and minute seta; apical palpomere small, about 0.33 × as wide as basal segment, with minute sensorium and 3 sensory papillae.

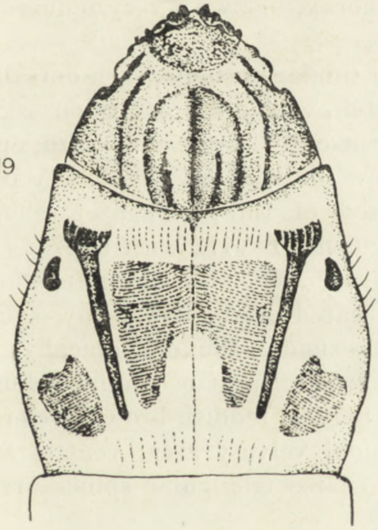
Thorax (Figs. 3, 4) about $^{1}/_{5}$ of total length Prothorax (Figs. 19, 20) broader

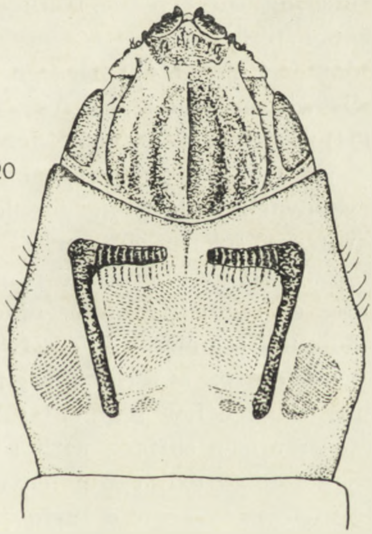

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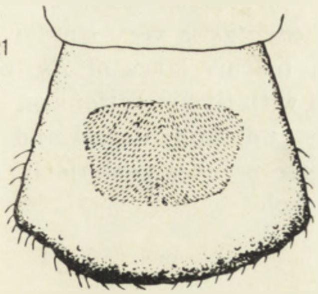

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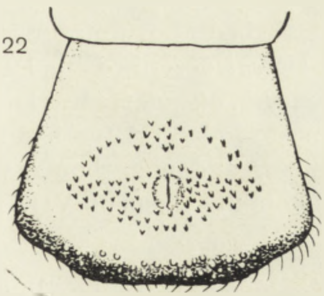

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18

19


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Figs. 15–22. *Rh. attenuatus*, larva. 15–18 — mandible, 19 — head anf prothorax, dorsal, 20 — same, ventral, 21 — abdominal segment IX, dorsal, 22 — same, ventral. 15 — first-instar, 16 — second-instar, 17 — third-instar, 18–22 — mature larva.

than other body segments, mesothorax same size as prothorax, metathorax slightly narrower than mesothorax. Pronotum (Fig. 19) with characteristic pair of dark-brown, horny, polished, club-shaped scleromes; interspace between scleromes with two triangular patches with velvety appearance consisting of microscopic scales, directed in genera lobliquely backwards (Fig. 14); dark--brown spot anteriorly and triangular velvety area posteriorly of lateral side of each sclerome. Ventral surface of prothorax (Fig. 20) with a pair of rod--shaped, longitudinal scleromes, like in inverted "L"; the inner arm deeply striated; interspace between scleromes with square velvety area; postero--laterad of sclerome triangular velvety patch of scales. Mesothorax dorsally and ventrally with two pale yellow, transverse, narrow, velvety, patches; between these oval areole medially of posterior third; spiracles situated on sides of segment, distinct. Metathorax similar to mesothorax, but with very reduced, non--functional spiracles.

Abdomen (Figs. 3, 4) with segments I–VII similar in shape, each dorsally and ventrally with middle transverse, velvety patch, which is broader on segments VI–VIII; posterior to patches there is areole medially in posterior third; epipleural area slightly protuberant, each bears a few short scales. All velvety patches show yellowish reflection. Areoles composed of thin, elongate, sclerotized ovals, without sclerotized central areas. Segments I–VIII with biforous spiracles surrounded by sclerotized ring (Fig. 11), situated laterally in anterior portions of each segment; microscopic scales situated above and below spiracles. IX abdominal segment (Figs. 21, 22) subtrapezioidal, rounded apically, about 1.5 times wider on anterior margin than long; basal part of similar colour and structure than other segments; posterior border reddish-brown, sclerotized and setose; upper surface with semitrapezoidal velvety area; ventral surface with semicircular excavation covered with coarse triangular spines arranged in concentric rows around furrow in middle.

Remarks

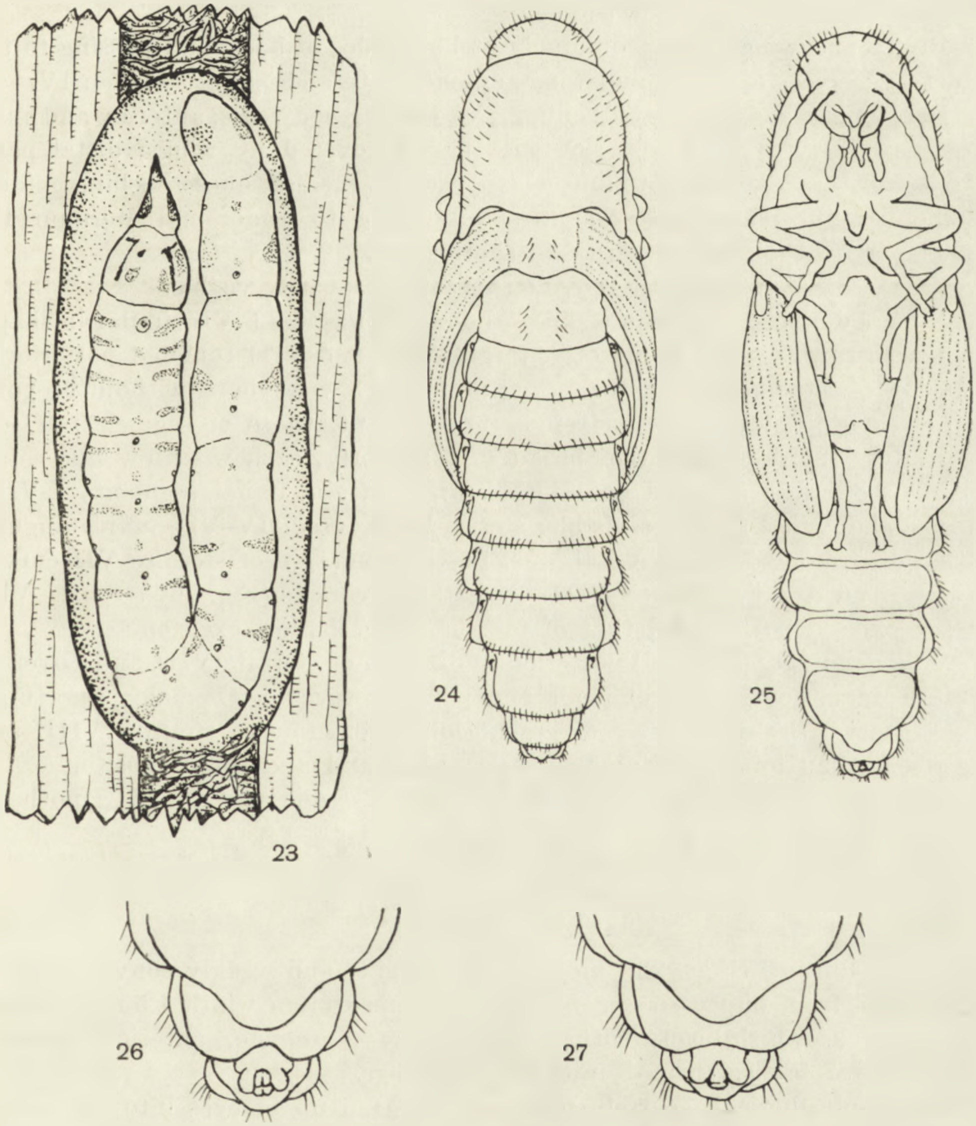
The described above mature larva of *Rh. attenuatus* is very similar to that of *Rh. sahlbergi* described by Palm (1958). The mature larva of *Rh. sahlbergi* differs from *Rh. attenuatus* by the following: head with five serrations on anterior margin, posterio-lateral tooth directed forwards and bifid; dorsal and ventral sides of meso- and metathorax without transverse patches posteriorly; ventral side of abdominal segment VIII without oval areole.

Pupa (Figs. 24–27)

Body elongate-oval with abdomen tapering posteriorly. Length 7.0 mm, maximum width 2,3 mm. Colour whitish with somewhat yellowish tinge when just

formed becoming dull brown with a beetle completely formed. Epiderm very feebly sclerotized, closely covered by microscopic pubescence and both longer and shorter setae which are sparse.

Head (Figs. 25) largery hidden from above, subglobular, strongly bent posteriorly beneath prothorax; head strictures not visible, vertex with dense, fine



Figs. 23–27. *Rh. attenuatus*. 23 – larva in pupal cell, 24 – pupa, dorsal, 25 – pupa, ventral, 26 – pupa, male abdominal segments VII–IX, ventral, 27 – same of female.

setae; antennae filiform, closely approximated, fitting between elytra and forelegs, extending beyond mid tibiae; mandibles, maxillae and labial palps well distinguished.

Pronotum almost trapezoidal, about as long as wide, with anterior margin rounded, widest at base; caudo-lateral angles prominent for at least $^{1}/_{5}$ of segment length; lateral parts covered with dense, erect setae. Meso- and metanotum subtrapezoidal, with few setae.

Elytra and wings fitting obliquely at both sides of body and passing to the underside; apices of elytra and wings extending to abdominal sternum IV.

Legs long, widely separated, clinging to ventral body side; anterior and middle legs clearly visible, posterior ones partly covered by wings; distal parts of anterior tarsi extending to mid tibiae, those of median ones reaching middle of metasternum, and posterior tarsi extending to abdominal sternum IV; apical part of each tarsus with two short setae.

Prosternal spine and its groove on mesothorax easily visible.

Nine abdominal segments visible. Abdominal tergites I–VI, similar in shape, each with row of setae posteriorly; tergites VII and VIII rounded posteriorly, with row of setae near posterior margin; tergite IX very short, without urogomphi, with few setae. Pleura strongly protuberant, those of segments III–VI with lateral borders excurved, broadest posteriorly, each with few fine setae. Spiracles circular, situated on lateral surface of abdominal segments I–VIII. Only 7 abdominal sternites visible; sterna I–III fused; IV–VI semirectangular with sides rounded, surface glabrous. Posterior margin of sternite VII curved and protruded over sternite VIII. In male specimens (Fig. 26) sternite VIII deeply excised posteriorly, that of females with shallow excision.

Male gonotheca (Fig. 26) posterior to excision of sternite VIII and covering genital organs, only apex of penis and parameres visible. Female pupa (Figs. 27) with two fleshy, slightly divergent lobes posterior to sternite VIII, and narrow median lobe covering two styli apices and apex of ovipositor.

Anal cone situated between posterior part of segment IX and gonotheca.

Adult (Figs. 28–37)

Body elliptical (Figs. 28), moderately elongate and weakly convex. Length of emerged from pupae specimens 5–6.5 mm, maximum width 1.5 mm. Colour brown to brownish-black with reddish-brown antennae, anterior pronotal edge, elytral bases, sutural intervals and legs.

Head subspherical, sparsely punctate, inserted up to eyes into prothorax. Eyes large. Frons broad, about as long as antennomere I. Antenna 11-segmented, in male its length equalling 3 times head width across eyes, and 2 times width in female. Antennal insertion well forward on frons, distant from eyes

and mandibles; antennomere I stout, longest and with outer margin weakly arcuate, II shortest; antennomere III about 3 ×as long as wide, IV–VIII subequal, serrate, IX–X slender and not serrate; apical antennomere elongate-oval, about 1.5 × longer than preceding one.

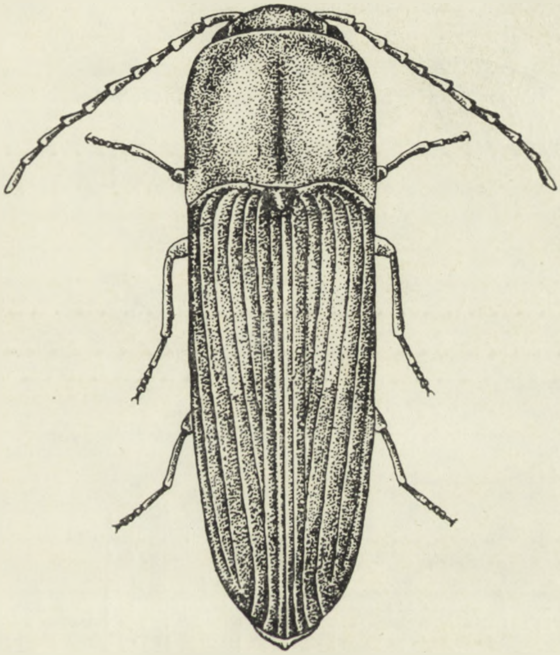


Fig. 28. *Rhacopus attenuatus* (Maeklin).

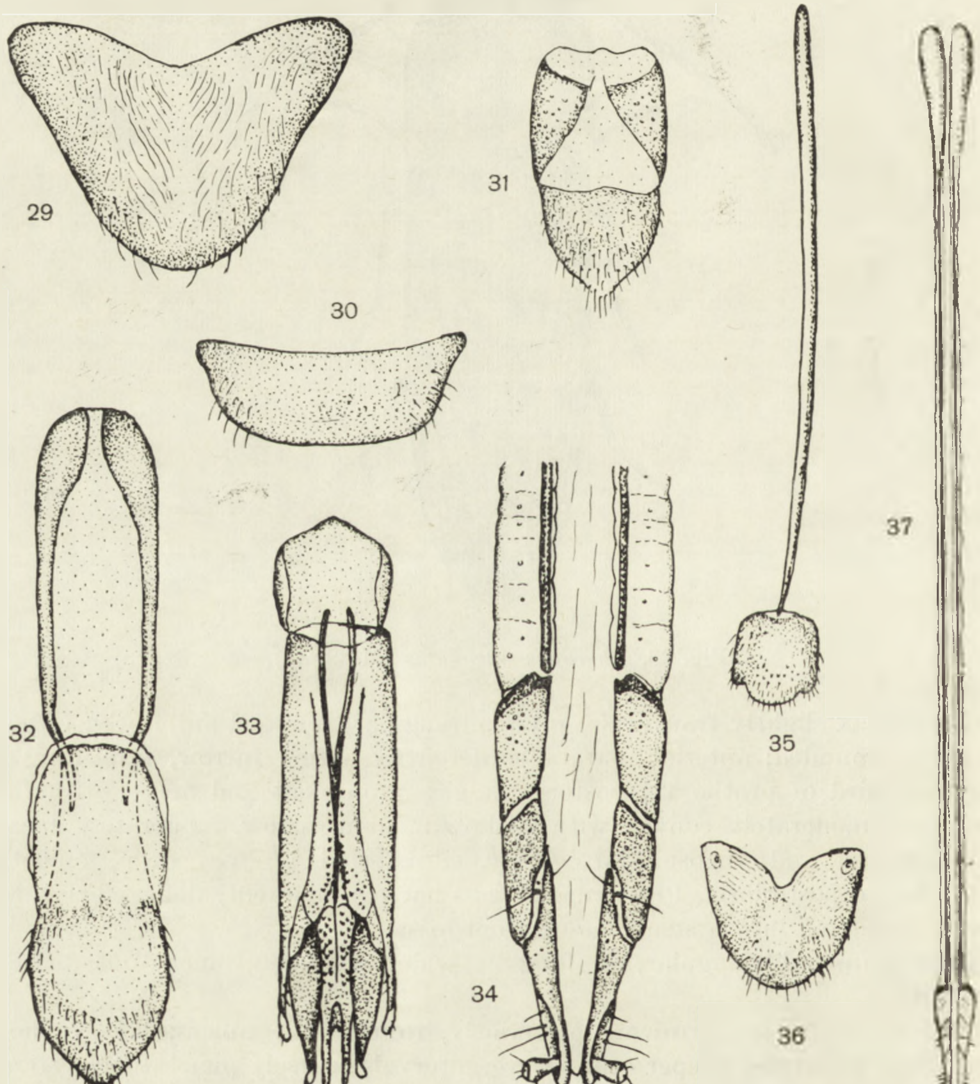
Prothorax slightly transverse, subquadrangular, rounded anteriorly; anterior angles rounded; anterior margin bordered by a fine furrow, appearing in anterior third of prothorax; posterior angles prominent and acute, with fine keel; disk moderately convex with shallow median furrow, moderately densely punctured and rugose transversely. Prosternal grooves deep, smooth, not enlarged posteriorly. Prosternal process narrow, markedly deflexed towards apex and fitting into a small mesosternal fossa.

Scutellum subtriangular, as long as wide, flattened, finely but densely punctate.

Elytra gradullay narrowing posteriorly, rounded at apices; striate-punctate, strial punctures deeper near suture; intervals coarsely punctate and transversely rugose. Last ventrite of abdomen obtuse apically.

Male abdominal terminalia. Tergite VIII (Fig. 29) subtriangular and rounded apically, pilose on posterior edge and densely pubescent dorsally. Sternite VIII (Fig. 30) short, subtrapezoidal with rounded hind angles bearing few

setae. Tergite IX (Fig. 31) subquadrangular with anterior edge excised. Tergite X linguliform, pilose apically. Sternum IX (Fig. 32) distinctly elongate, subtrapezoidal anteriorly, and liguliform posteriorly, sclerotized laterally with membraneous median part, densely pilose posteriorly and laterally. Sternite X (Fig. 32) elongate, membraneous, anterior margin broadly convex; its base



Figs. 29–37. *Rh. attenuatus*, adult. 29–33 – male, 34–37 female. 29, 36 – tergite VIII, 30, 35 – sternite VIII, 31 – tergites IX, X, 32 – sternites IX, X, 33 – aedeagus, 34 – valves, 37 – abdominal segment IX and ovipositor.

connected with posterior part of sternite IX and free apex directed forward. Aedeagus (Fig. 33) of trilobed-type with basal piece shorter than 3 × the length of parameres, membraneous centrally and sclerotized laterally; parameres narrowly elongate, flattened horizontally, stout at base, posteriorly with slender processes bearing small, apical setae; median lobe (penis) strong, stout basally, gradually tapering median and lateral processes; its base produced into two long median struts, median orifice situated between median processes, internal sac elongate, covered with fine spinules.

Female abdominal terminalia. Tergite VIII (Fig. 36) slightly emarginate anteriorly, rounded apically and pilose, dorsal surface pubescent. Sternite VIII (Fig. 35) subtrapezoidal, rounded posteriorly, covered with minute setae, articulated strut about 6 × as long as sternum. Ovipositor (Figs. 34, 37) very elongate, slightly sclerotized; tergite IX (Fig. 34) consisting of two elongate, membraneous sclerites bearing ventrally two baculi about 9 × as long as sternite IX; sternite IX (Fig. 34) consists of two triangular sclerites, partly divided into three elongate plates bearing sparse pores and a few setae, base of sternite articulated with baculi; each small stylus with four sensorial bristles; vulva located between posterior part of hemisternites; without sclerotized spermatheca.

Collecting and rearing data, and notes on bionomy

Poland, Białowieża Primeval Forest, section 192, *Circaeo-Alnetum*, in shady and moist sites, a large, decaying stump of *Populus tremula* L., at depth 10–30 mm, in whitish-rotting, damp sapwood, within oval cells, numerous mature larvae assumed a U-shaped position (Fig. 23), 10 May 1959. Six larvae preserved in alcohol, were used for this study, and remainder reared in the laboratory. Larvae were transferred along with damp, decayed sapwood into stoppered glass jars of 1.5 l. capacity; a few larvae were reared in glass tubes 15 × 80 mm stoppered by moistened scroll of cotton-wool. First pupa observed on May 13, last pupae on May 25; 14 adults emerged May 29–June 4; mating observed on June 4; numerous larvae of first and second-instar were observed on July 11 moving in water on bottom of jar, several larvae preserved in alcohol were used for this study. A few exuviae of fourth or fifth instar were found on September 14, in dry wood; the latter reared without results.

Adults of *Rh. attenuatus* posses a capacity for leaping when lying on their back. Adult leaps rather unwillingly, and at first remains on its back with all appendages retracted (sometimes for 10 minutes), then tries to turn at normal position by the seizure of substrat by its legs with some antennal help from time to time, leaning them upon the substrate; failling to do this, the beetle retracts its appendages and leaps up to 20–30 mm high (on hard substrate up to 60 mm), turns around and falls normally on its legs. Sometimes, however,

failing again on its back, the beetle may repeat leaping several times up to assumption of normal position.

The mating takes place only while a female moves around; the female does not receive a male in resting position. The observed copulation lasted from 2 to 3 minutes

Distribution

This species seem to be a relict element, found in isolated localities in Finland, Poland, Hungary, Austria, Yugoslavia and Rumania.

General remarks

The early instar larva of the European eucnemid was described for the first time by PERRIS (1871). He described and figured two larval forms of *Farsus dubius* (PILLER et MITTERPACHER, 1783) under the name *Farsus unicolor* (LATREILLE, 1834). Both larvae are legless. The first form is elongate-elliptical, 7 mm long, strongly flattened, white, feebly shiny, smooth and glabrous. Because of its length it should be classified as one of later instars, probably a penultimate one. The second form described is a typical mature larva, known in many other species of *Eucnemidae*.

In 1926 GARDNER has described and figured "first-instar" larva of the Indian species *Fornax gardneri* FLEUT. The larva is legless, 1.5 mm long, with head fairly similar to first and second-instars of *Rh. attenuatus*. It seems probable that it was the second stage, not the first. GARDNER (1935) has described an early instar larva of another Oriental species, *Arhipis orientalis* FLEUT. This larva is broadly-oval, 2.5 mm long, flattened and differs from the mature, elongate larva by different mouth-parts structure. This seems to be also one of later instars, similar to that described by PERRIS (1871).

It should be also mentioned that there are two larval forms, recently discovered, in *Eucnemis capucinus* AHR., with the last-instar markedly different than the preceding ones that have been known for a long time.

From the above presented descriptions and literature data it seems to be apparent that hypermetamorphosis may occur in *Eucnemidae* in different stages of development.

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STRESZCZENIE

[Tytuł: Hipermetamorfoza *Rhacopus attenuatus* (Maeklin) (*Coleoptera*, *Eucnemidae*)]

Podano opisy i ilustracje młodszych postaci rozwojowych *Rhacopus attenuatus* (Maeklin), u którego po raz pierwszy w rodzinie *Eucnemidae* odkryto występowanie stadiów larwalnych znacznie różniących się od siebie morfologicznie. Pierwsze stadium larwalne ma dobrze wykształcone nogi i długie filamenty na krętarzach i końcu odwłoka, porusza się ono aktywnie w kroplach wody i jest bardzo krótkotrwałe. Drugie stadium larwalne jest beznogie, lecz zachowuje filamenty na końcu odwłoka i występuje w tym samym środowisku co poprzednie. Dalsze stadia larwalne w zasadzie nie odbiegają od innych znanych przedstawicieli *Eucnemidae*. Podano też krótki opis imago ze szczególnym uwzględnieniem samczych i samiczych narządów rozrodczych. W zakończeniu podano krótkie uwagi o bionomii i występowaniu *Rh. attenuatus* oraz wskazano na możliwość występowania nadprzeobrażenia i u innych gatunków *Eucnemidae*.

РЕЗЮМЕ

[Заглавие: Сверхметаморфоз *Rhacopus attenuatus* (Maeklin) (*Coleoptera*, *Eucnemidae*)]

Приведены описания и иллюстрации ювенальных стадий *Rhacopus attenuatus* (Maeklin), у которого впервые в семействе *Eucnemidae* обнаружено,

что личиночные стадии развития значительно отличаются морфологически. Первая личиночная стадия имеет хорошо развитые ноги и длинные филаменты на вертлугах и на конце брюшка, активно передвигается в воде и очень непродолжительнан. Вторая личиночная стадия лишена ног, но филаменты на конце брюшка сохранаются, и пребывает она в той же среде, что предыдущая. Следующие стадии развития не отличаются морфологически от других известных представителей *Eucnemidae*. Приведено также краткое описание имаго с особым учетом строения половых органов самцов и самок. В заключении приведены краткие замечания по биономии и распространению *Rh. attenuatus*, а также указывается на возможность существования описанного типа превращения также у других предсавителей *Eucnemidae*.

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